- The 'Aina Institute is a 501 (C) (3) Non-Profit Organization
- Established in 1991
- **GOAL**
- Developing sustainable technology in food production and energy production.
  - Education ,
  - Research,
  - Demonstration ,
  - Technology Transfer
  - Development,

  Activities include the application of bioconversion technologies to meet local needs for food, water and energy while maintaining or improving the quality of the environment.

This is a discussion about:

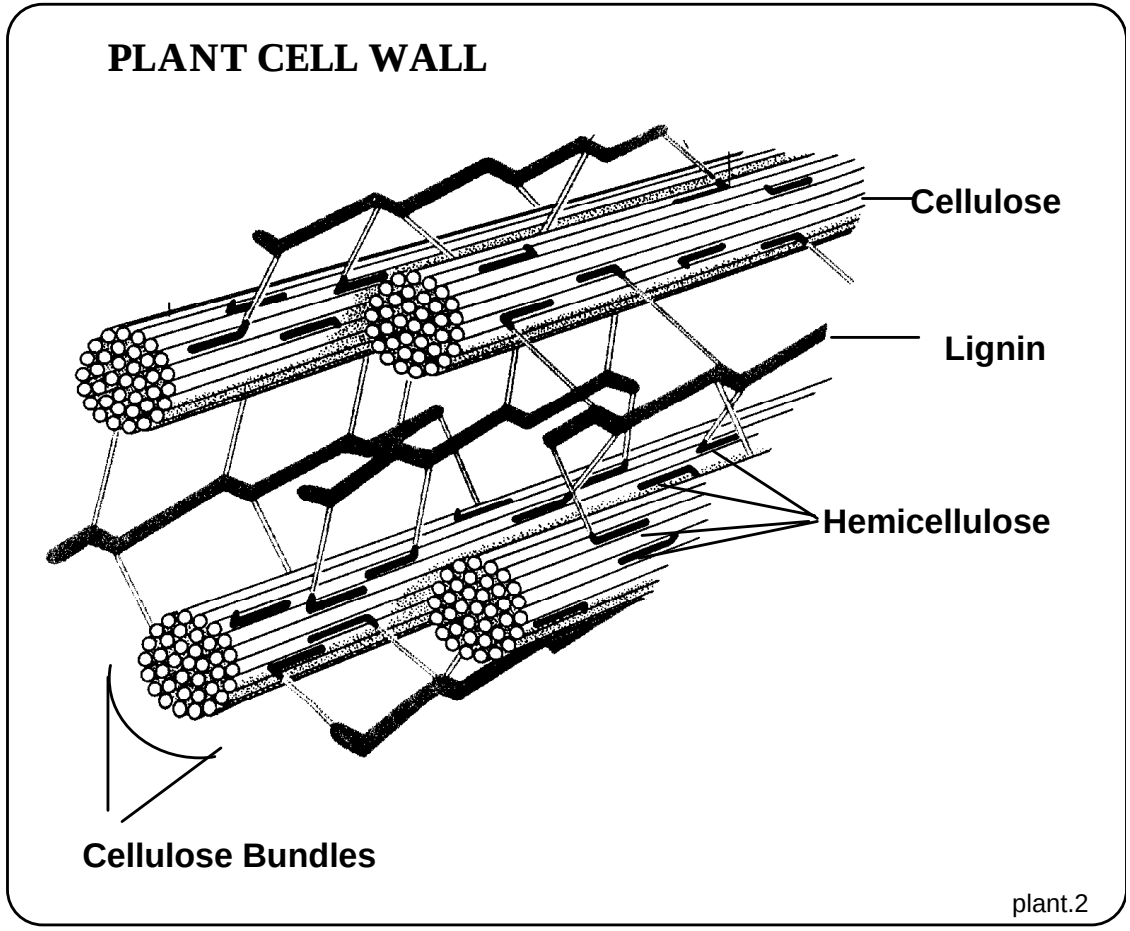
ETHANOL TECHNOLOGY

&

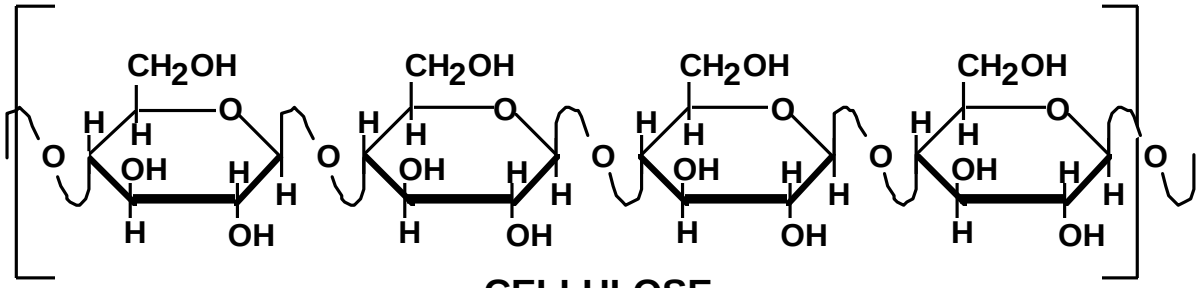
“Waste Our Most Sustainable Resource”

Wasting Waste is Wasteful !

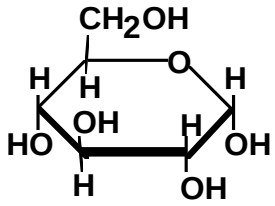
BIOMASS – ETHANOL BACKGROUND



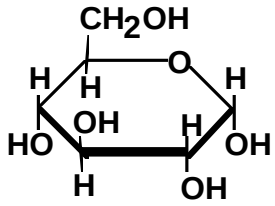
BIOMASS – ETHANOL BACKGROUND



HYDROLYSIS

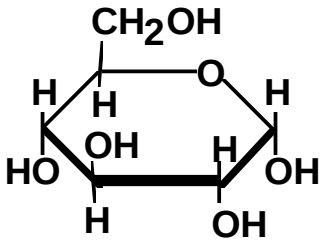


GLUCOSE



GLUCOSE

Sugar Fermentation

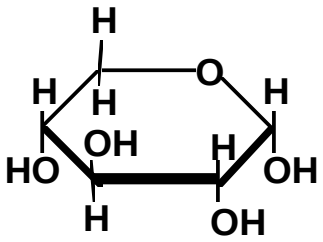


fermentation →

$CH_3\ CH_2\ OH$ + CO_2

$CH_3\ CH_2\ OH$ + CO_2

(1) GLUCOSE —fermentation→ **(2) ETHANOL** + **(2) CARBON DIOXIDE**

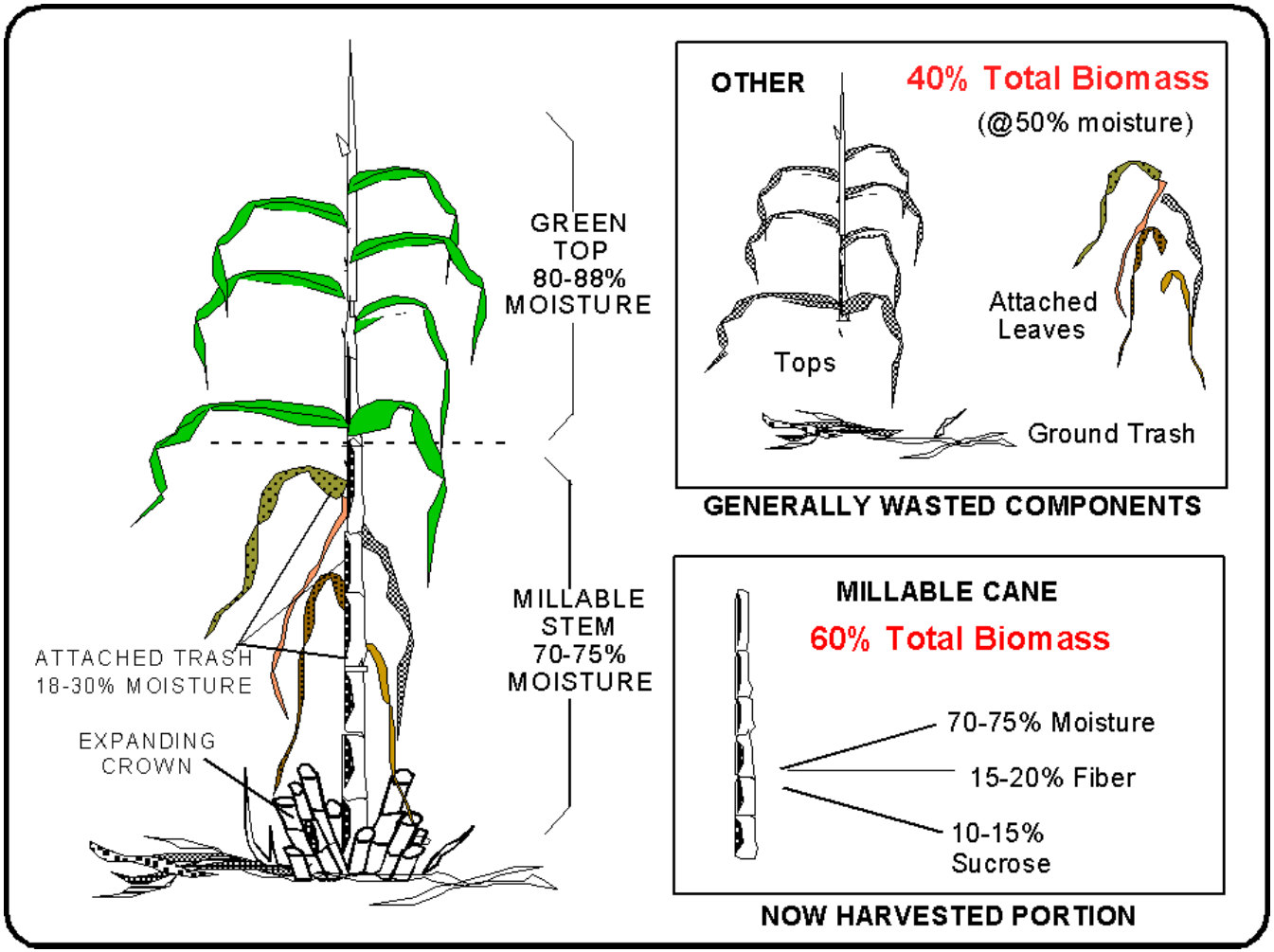


XYLOSE —fermentation→ **ETHANOL** + **CARBON DIOXIDE** + **WATER**

BIOMASS COMPOSITION
(% by dry-weight)

Biomass Source	Sugars	Cellulose	Hemicellulose	Lignin	Other
Bagasse	3	38	27	**20**	**12**
Sugarcane ("prepared" cane)	43	22	15	**11**	**9**
Sugarcane leaves	--	36	21	**16**	**27**
Sugarcane (whole plant)	33	25	17	**12**	**13**
Napier grass	--	32	20	**9**	**39**
Sweet sorghum	34	36	16	**10**	**3**
Eucalyptus grandis	--	38	13	**37**	**12**
Eucalyptus saligna	--	45	12	**25**	**18**
Leucaena leucocephala	--	43	14	**25**	**18**
Municipal Solid Waste	--	33	9	**17**	**41**
Newspaper	--	62	16	**21**	**1**

Sugar Crop Biomass



HAWAII MSW COMPOSITION

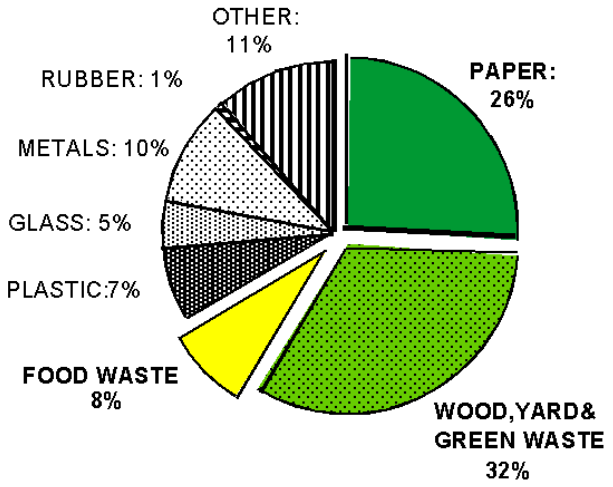
MSW - ENERGY/ ETHANOL POTENTIAL

Paper·····24%

Food.·····8%

Wood Yard Green····· 32%

TOTAL·····64 %



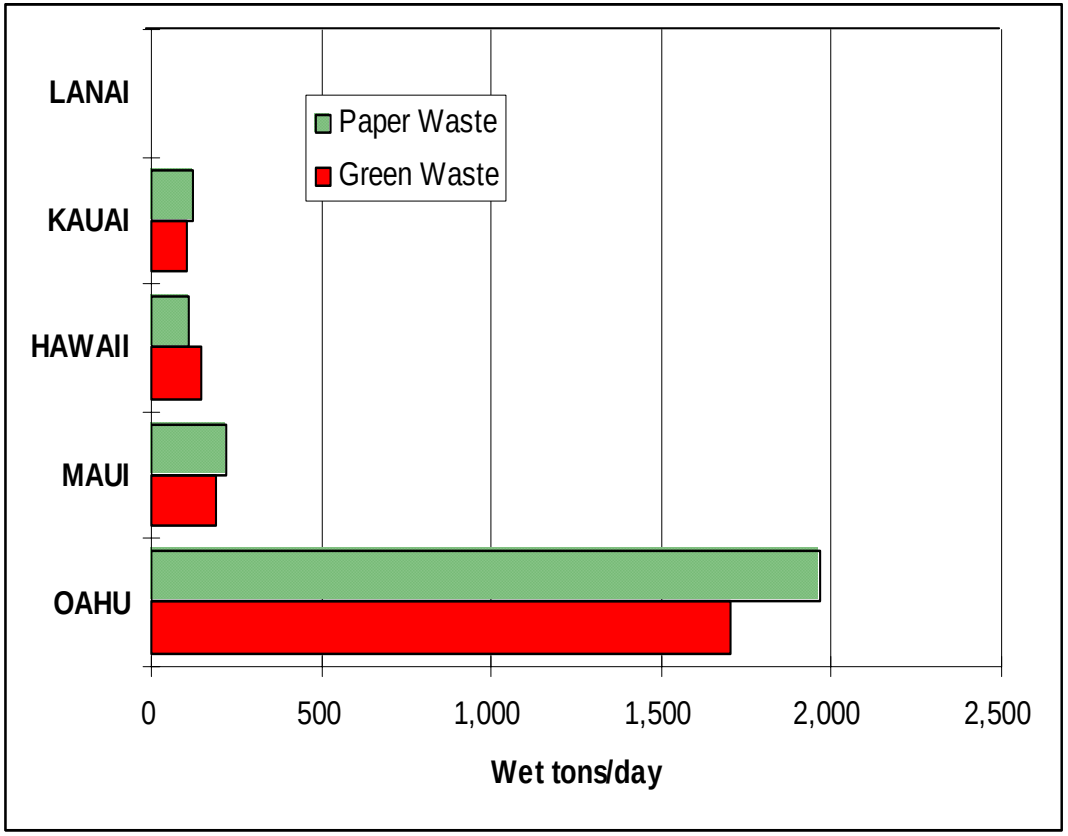
There are major opportunities to produce biomass from waste

- Producing Ethanol from sugar limits opportunities
- Producing Ethanol from corn seed alone limits opportunities

- Substantial research has focused on producing ethanol from biomass and wastes
  - **CO_2 loss in fermentation reduces yields**
  - **Enzyme cost and performance must be considered**.

- Process costs and reliability are still major issues

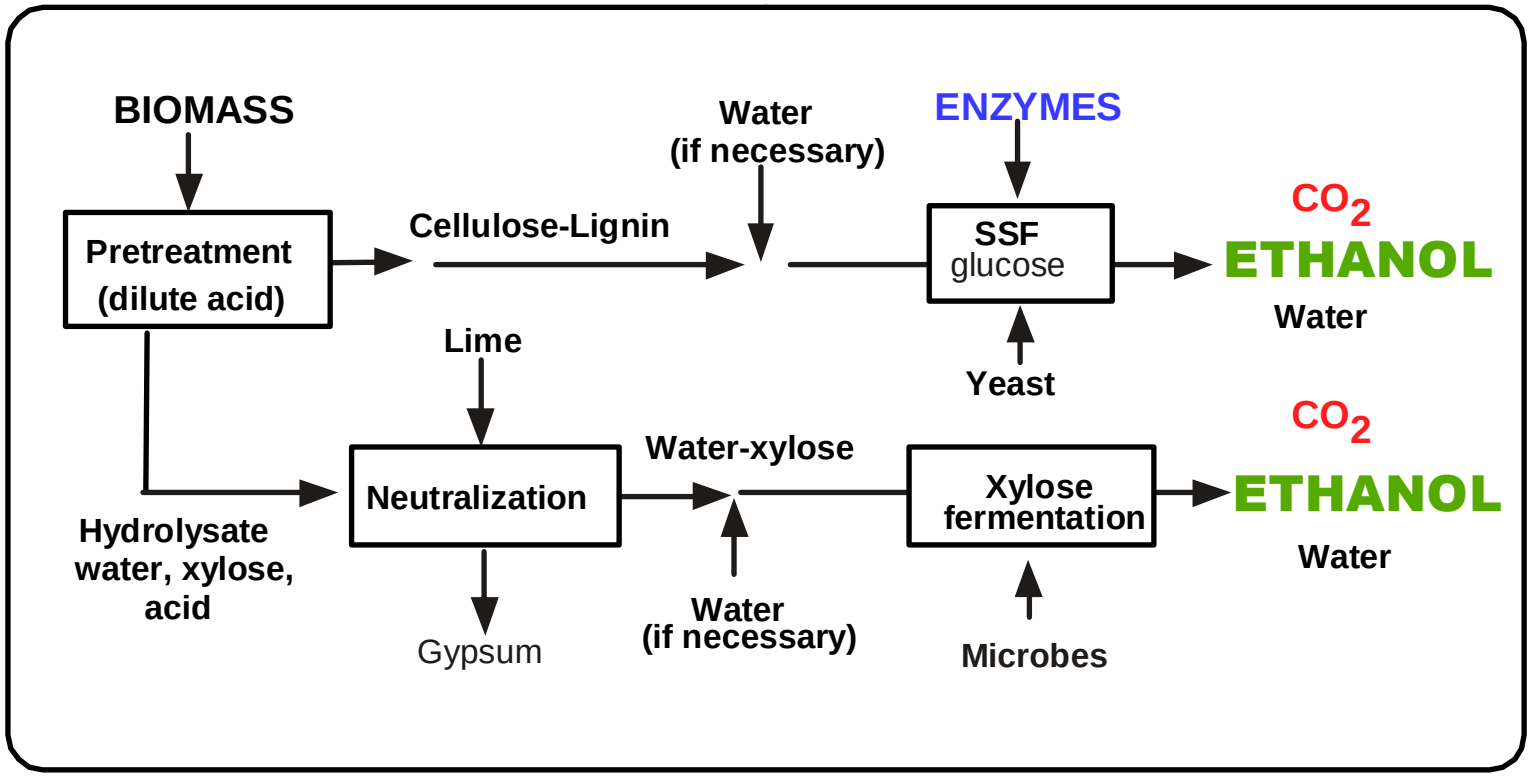
Hawaii Paper &Green Waste



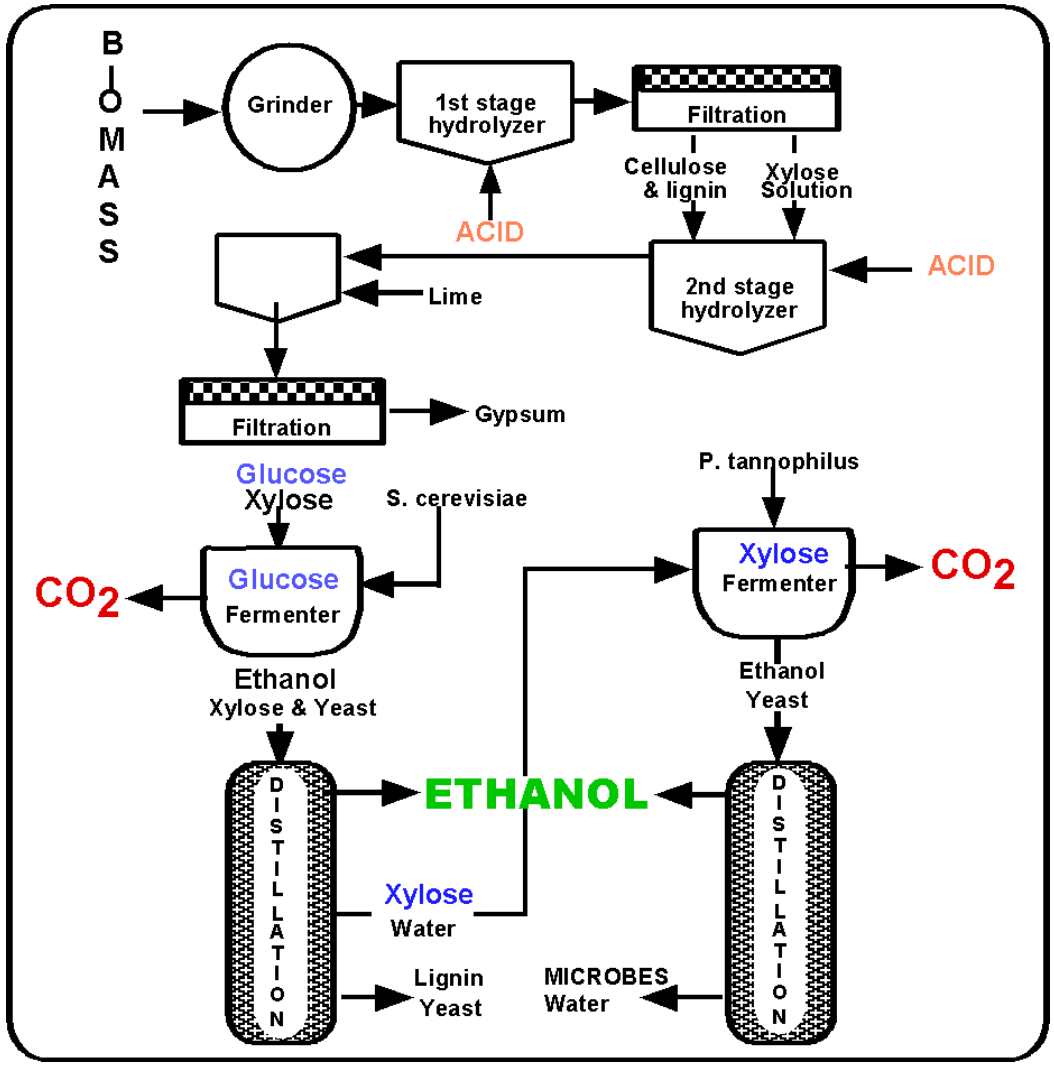
TECHNOLOGY REVIEW

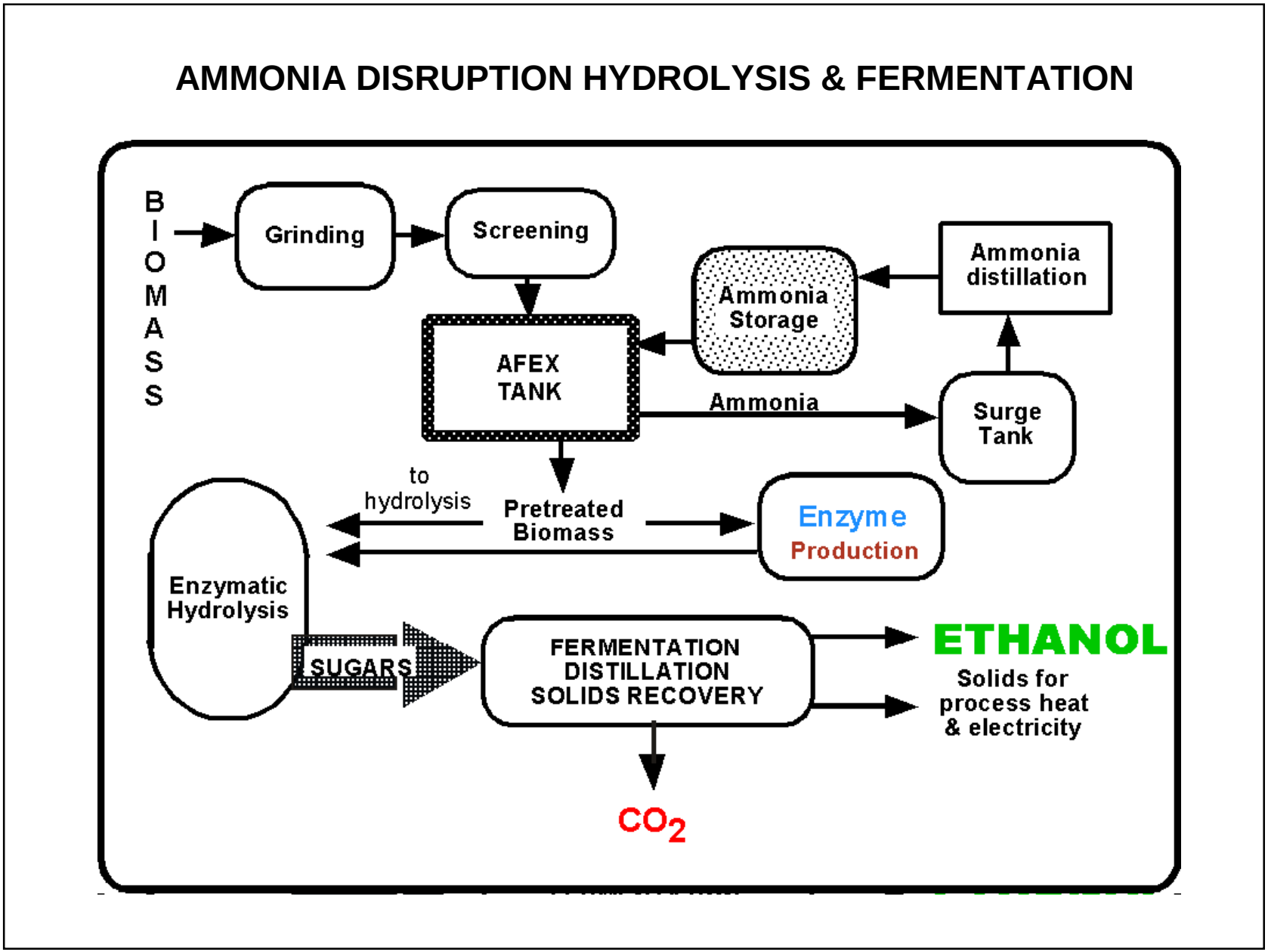
- A Brief Survey of Biomass-Ethanol Technologies
- A Look at Present and Future Opportunities

SIMULTANEOUS SACCHARIFICATION and FERMENTATION

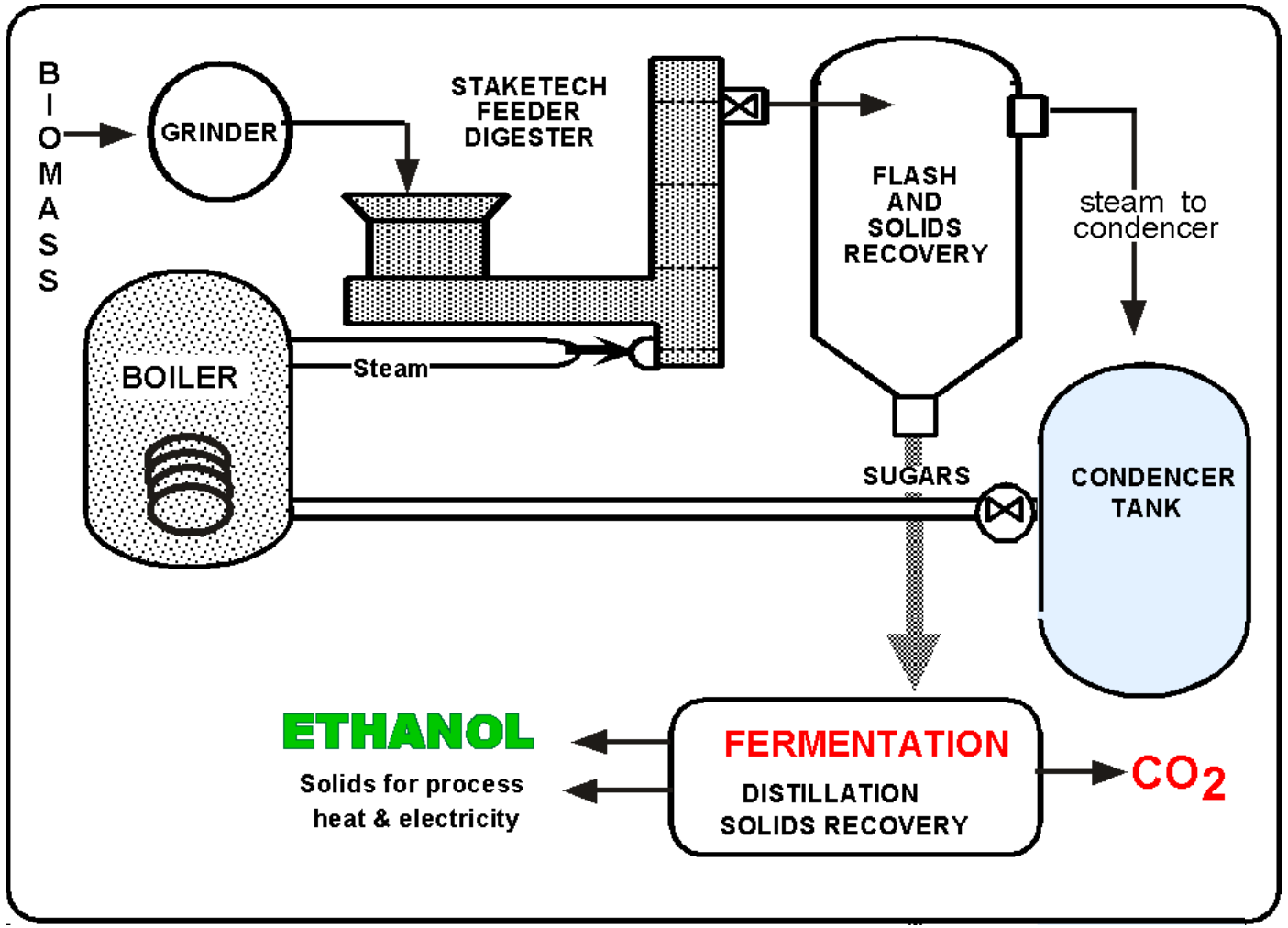


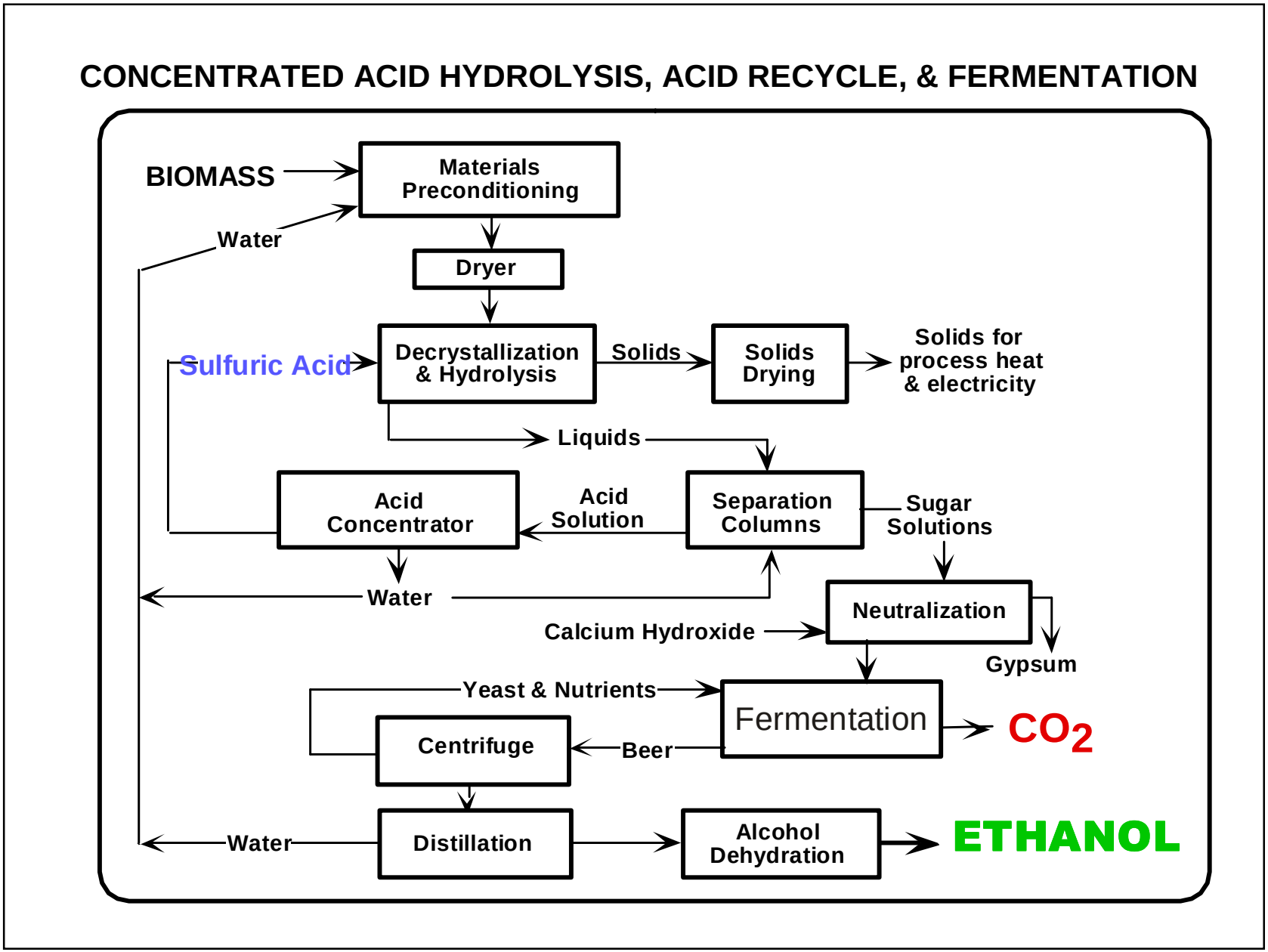
CONCENTRATED ACID HYDROLYSIS NUTRALIZATION & FERMENTATION



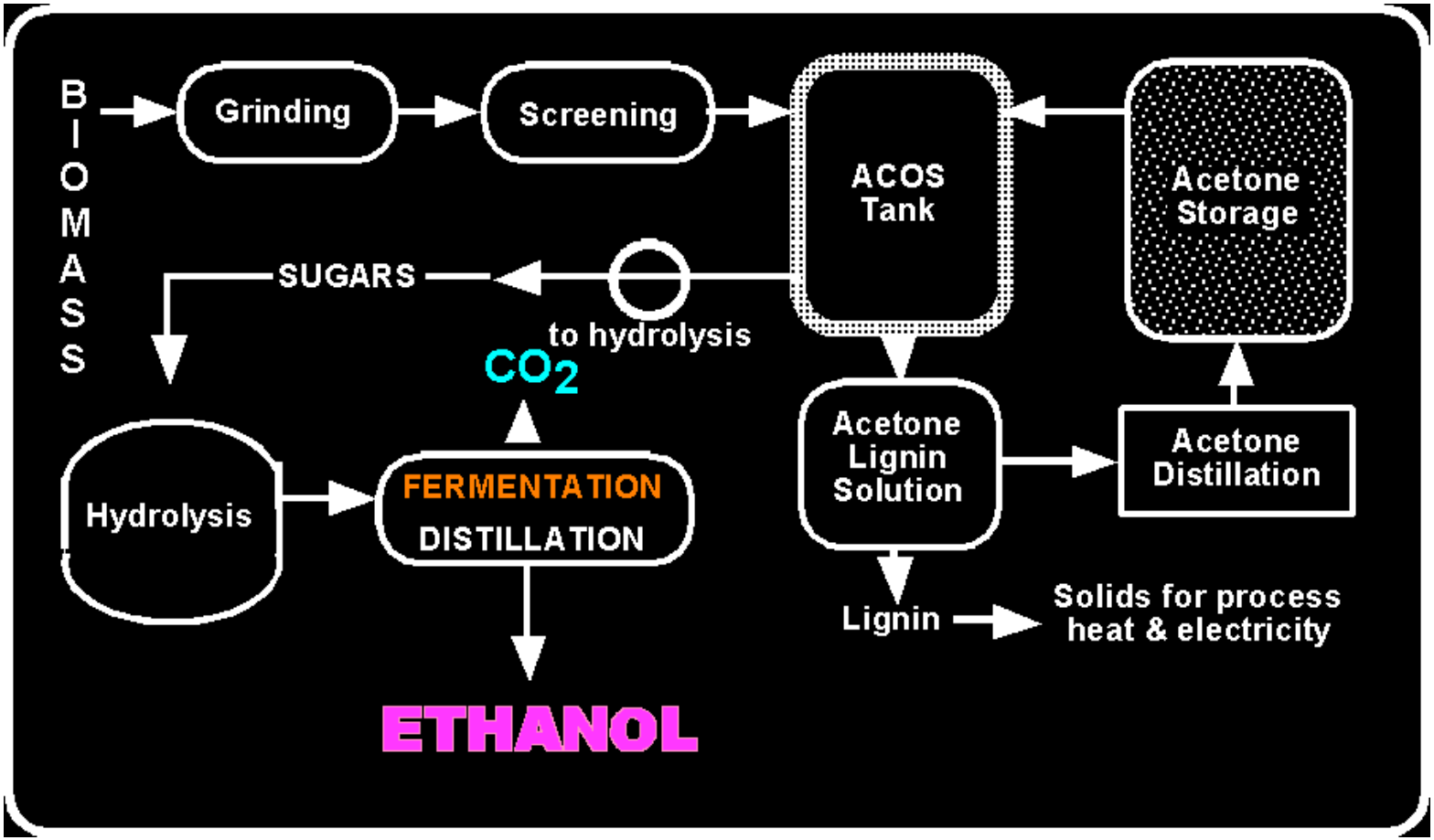

AMMONIA DISRUPTION HYDROLYSIS & FERMENTATION
BIOMASS
Grinding
Screening
Ammonia distillation
Ammonia Storage
AFEX TANK
Ammonia
Surge Tank
to hydrolysis
Pretreated Biomass
Enzyme Production
Enzymatic Hydrolysis
SUGARS
FERMENTATION DISTILLATION SOLIDS RECOVERY
ETHANOL
Solids for process heat & electricity
CO2

STEAM DISRUPTION HYDROLYSIS FERMENTATION

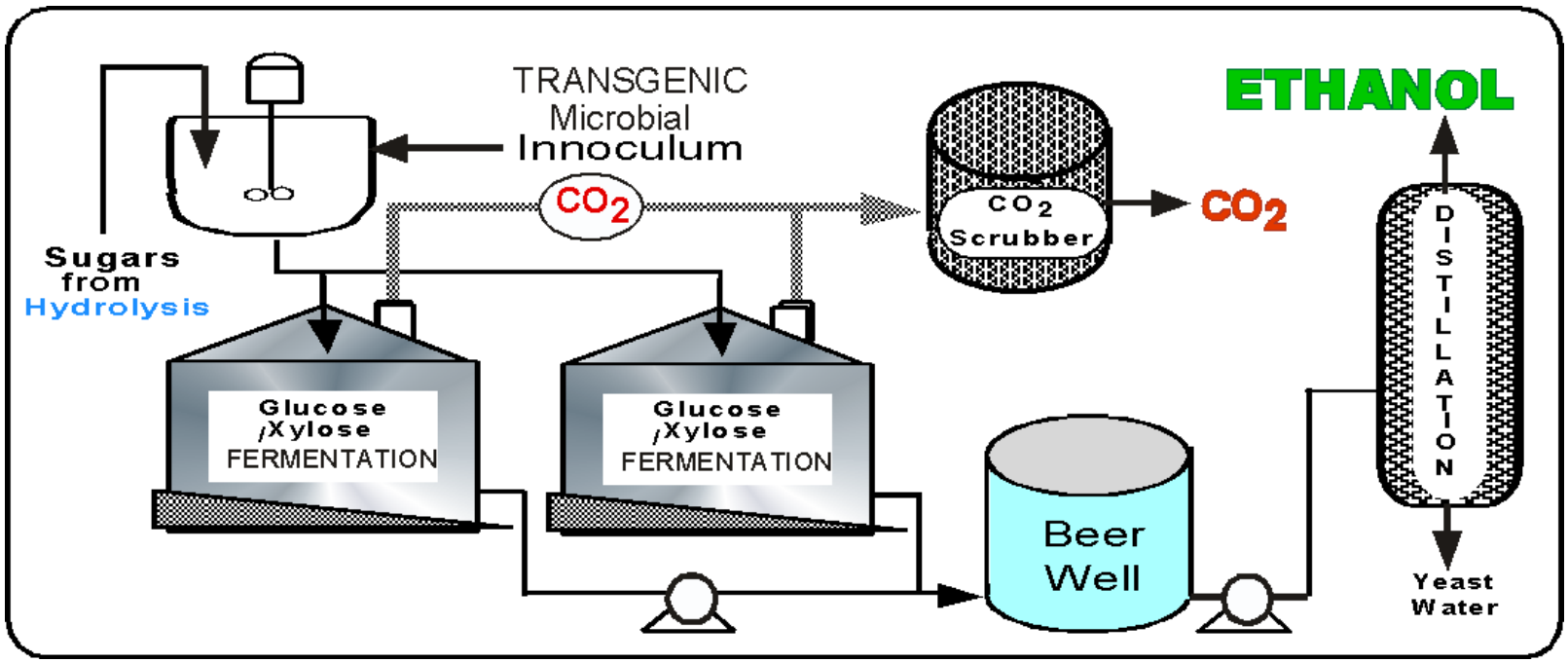



CONCENTRATED ACID HYDROLYSIS, ACID RECYCLE, & FERMENTATION
BIOMASS
Materials Preconditioning
Water
Dryer
Sulfuric Acid
Decrystallization & Hydrolysis
Solids
Solids Drying
Solids for process heat & electricity
Liquids
Acid Concentrator
Acid Solution
Separation Columns
Sugar Solutions
Water
Neutralization
Calcium Hydroxide
Gypsum
Yeast & Nutrients
Fermentation
CO2
Centrifuge
Beer
Water
Distillation
Alcohol Dehydration
ETHANOL

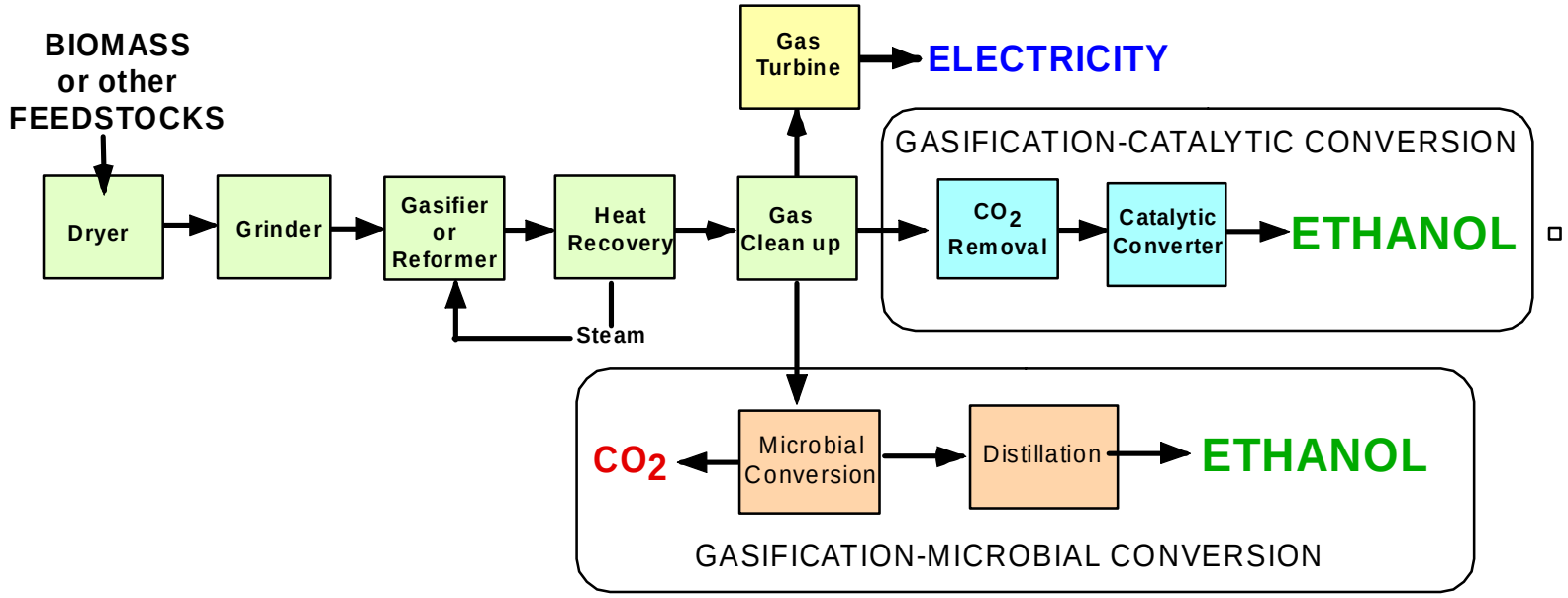
ACIDIFIED ACETONE EXTRACTION HYDROLYSIS & FERMENTATION



ACID DISRUPTION AND TRANSGENIC MICROORGANISM FERMENTATION

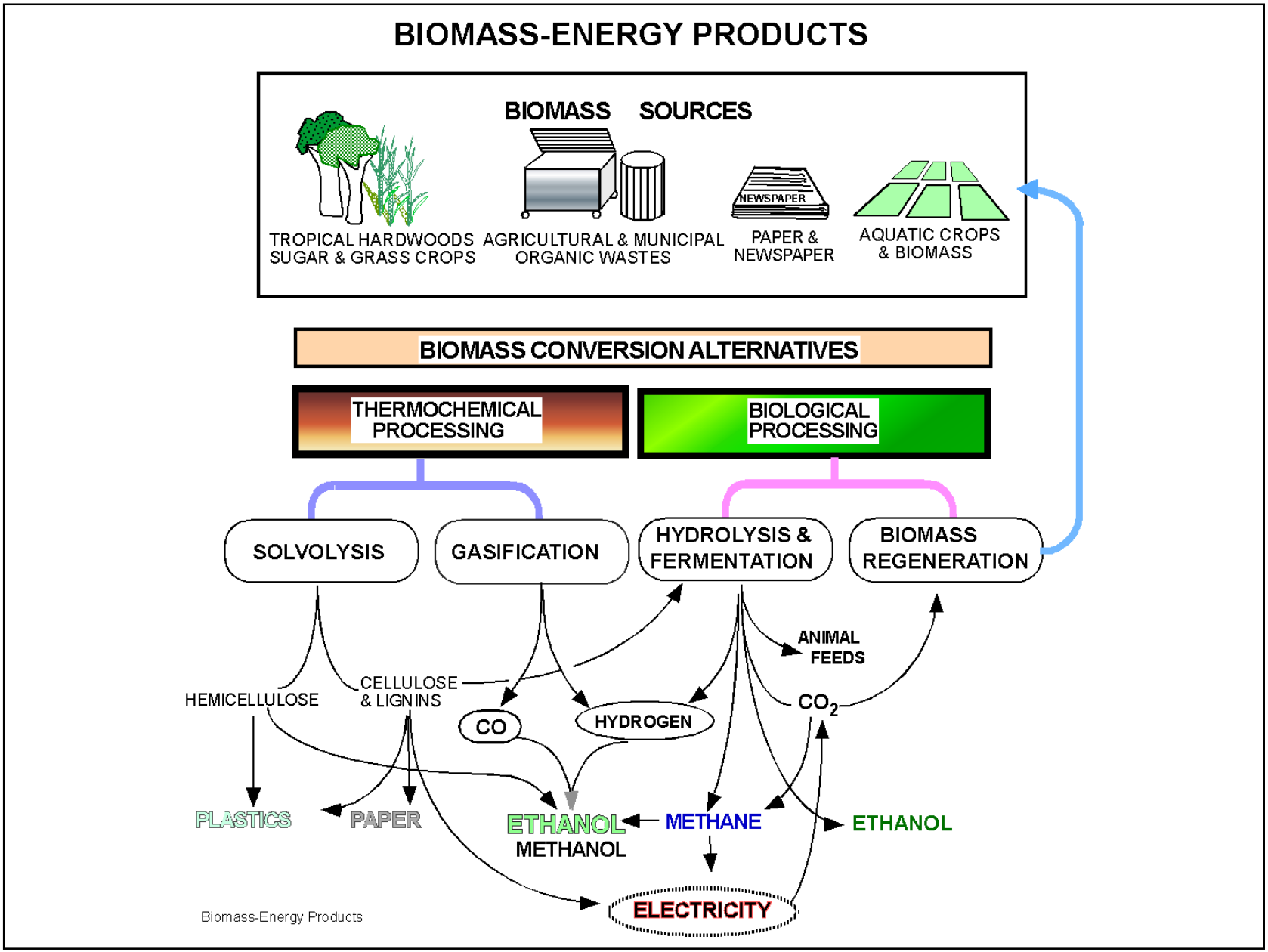


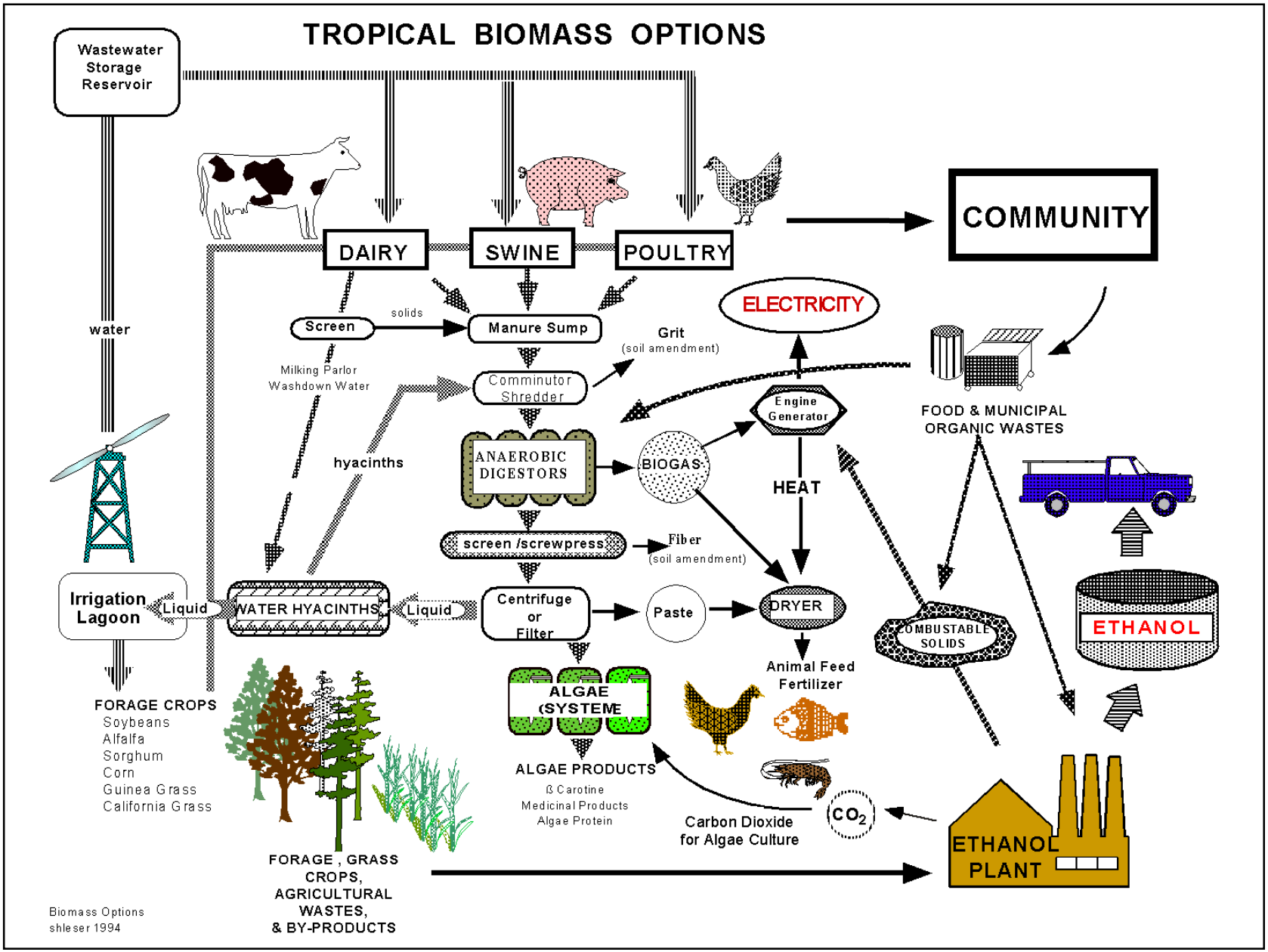
GASIFICATION - ETHANOL TECHNOLOGY



ETHANOL PROCESSES COMPARISONS

STATUS OF ETHANOL PRODUCTION TECHNOLOGY					
METHOD	**PRODUCTS**	**ADVANTAGES**	**DISADVANTAGES**	**COMMENTS**	**YIELD (gal./ dry ton)**
Molasses > Fermentation> Ethanol	Ethanol , Carbon Dioxide, Concentrated Molasses solids	Simple traditional yeast fermentation method	Limited supply- Half sugar becomes carbon dioxide, residue is concentrated molasses solids / may have disposal problem	Depends on Molasses from sugar indstry Lack of efficiency, Only 50% of sugars converted to ethanol	70-80
Corn> Processing > **Fermentation** > Ethanol	Ethanol Distillers dried grains Carbon Dioxide	Good for corn industry	Not applicable to Hawaii at this time	Lack of efficiency, only 50% of sugars are converted to ethanol	110-120
Fiber treatment by acid, ammonia, steam, or solvents to release sugars that can be fermented to produce ethanol	Ethanol, Carbon Dioxide, Lignin (SSF-BCI)	Converts any fiber source including paper and yard waste to ethanol	Half sugar becomes carbon dioxide, residue may have disposal problem	Lack of efficiency, only 50% of sugars are converted to ethanol	50 - 90
Wood fiber and Carbon containing molecules>gasification> carbon monoxide>with **bioconversion>ethanol**	Ethanol ,Water microbes	Can use most carbon containing materials that can be gasified to produce carbon monoxide and hydrogen	Depends on performance of microorganisms concerns about stability -reliability of culture	Technologies are not yet demonstrated commercially	80-100
Wood fiber and Carbon containing molecules>gasification> carbon monoxide/ hydrogen> **catalytic conversion >ethanol**	Ethanol Butanol Propanol	Can use most carbon containing materials that can be gasified to produce carbon monoxide and hydrogen. Ethanol is produced as a gas	Sensitive to performance of catalyst	Technology not demonstrated commercially	180 +


BIOMASS-ENERGY PRODUCTS
BIOMASS SOURCES
NEWSPAPER
TROPICAL HARDWOODS
SUGAR & GRASS CROPS
AGRICULTURAL & MUNICIPAL
ORGANIC WASTES
PAPER &
NEWSPAPER
AQUATIC CROPS
& BIOMASS
BIOMASS CONVERSION ALTERNATIVES
THERMOCHEMICAL
PROCESSING
BIOLOGICAL
PROCESSING
SOLVOLYSIS
GASIFICATION
HYDROLYSIS &
FERMENTATION
BIOMASS
REGENERATION
ANIMAL
FEEDS
HEMICELLULOSE
CELLULOSE
& LIGNINS
CO
HYDROGEN
CO_2
PLASTICS
PAPER
ETHANOL
METHANOL
METHANE
ETHANOL
ELECTRICITY
Biomass-Energy Products


TROPICAL BIOMASS OPTIONS
Wastewater Storage Reservoir
water
DAIRY
SWINE
POULTRY
COMMUNITY
Screen
solids
Manure Sump
Grit
(soil amendment)
Milking Parlor Washdown Water
Comminutor Shredder
ELECTRICITY
Engine Generator
FOOD & MUNICIPAL ORGANIC WASTES
hyacinths
ANAEROBIC DIGESTORS
BIOGAS
HEAT
screen /screwpress
Fiber
(soil amendment)
Irrigation Lagoon
Liquid
WATER HYACINTHS
Liquid
Centrifuge or Filter
Paste
DRYER
COMBUSTABLE SOLIDS
ETHANOL
Animal Feed
Fertilizer
FORAGE CROPS
Soybeans
Alfalfa
Sorghum
Corn
Guinea Grass
California Grass
ALGAE (SYSTEME
ALGAE PRODUCTS
ß Carotine
Medicinal Products
Algae Protein
Carbon Dioxide for Algae Culture
CO2
ETHANOL PLANT
FORAGE , GRASS CROPS, AGRICULTURAL WASTES, & BY-PRODUCTS
Biomass Options
shleser 1994

WASTING
WASTE
IS
WASTEFUL !